Distributed ReStart

Energy restoration for tomorrow

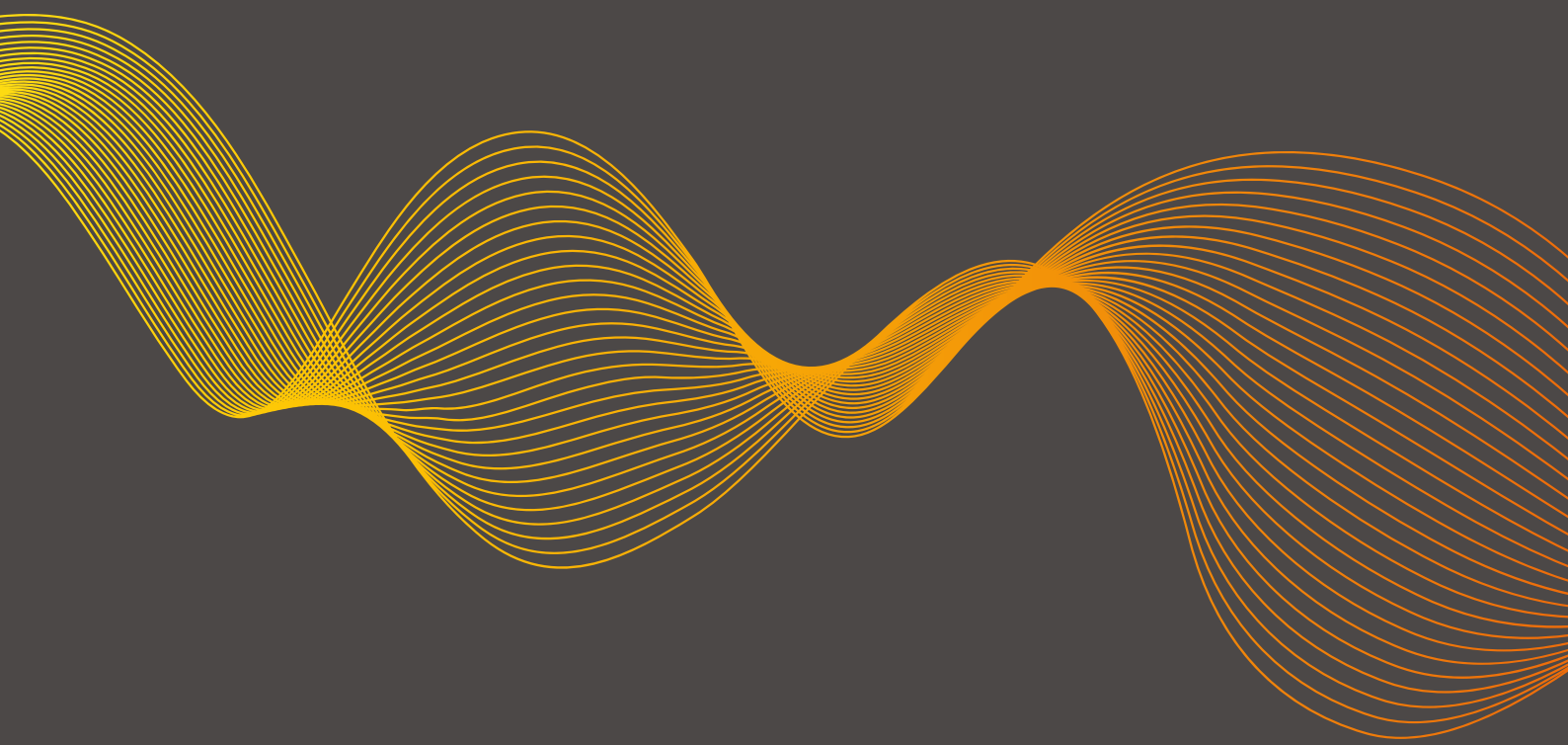
Project progress report June 2021

In partnership with:

tnei

SP ENERGY NETWORKS

nationalgridESO



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Project Overview

The Distributed ReStart project is a partnership between National Grid Electricity System Operator (ESO), SP Energy Networks (SPEN) and TNEI (a specialist energy consultancy) that has been awarded £10.3 million of Network Innovation Competition (NIC) funding.

The project is exploring how distributed energy resources (DER) can be used to restore power in the highly unlikely event of a total or partial shutdown of the National Electricity Transmission System. Past and current approaches rely on large power stations, but as the UK moves to cleaner and more decentralised energy, new options must be developed. The enormous growth in DER presents an opportunity to develop a radically different approach to system restoration. Greater diversity in Black Start provision will improve resilience and increase competition leading to reductions in both cost and carbon emissions. However, there are significant technical, organisational and commercial challenges to address.

The project is tackling these challenges in a three-year programme (Jan 2019 – Mar 2022) that aims to develop and demonstrate new approaches, with the possibility of commencing procurement activities for an initial Black Start service from DER from mid-2022 if deemed feasible and cost-effective. Case studies on the SP Distribution (SPD) and SP Manweb (SPM) networks will be used to explore options then design and test solutions through a combination of detailed off-line analysis, stakeholder engagement and industry consultation, desktop exercises, and real-life trials of the re-energisation process.

Project Description

The project is made up of five workstreams. The Project Direction and Knowledge Dissemination workstreams cover the effective management of the project and ensure stakeholders are considered and communicated with throughout all project deliverables. The other three workstreams cover the wide range of issues to enable Black Start services from DER:

- The Organisational Systems & Telecommunications (OST) workstream is considering the DER-based restoration process in terms of the different roles, responsibilities and relationships needed across the industry to implement at scale. It is developing requirements for information systems and telecommunications, recognising the need for resilience and cyber security, and the challenges of coordinating Black Start across a large number of parties. Proposed processes and working methods will be tested this year, in desktop exercises, involving a range of stakeholders, both internal and external.
- The Power Engineering & Trials (PET) workstream is concerned with assessing the capability of GB distribution networks and installed DER to deliver an effective restoration service. It will identify the technical requirements that should apply on an enduring basis. This will be done through detailed analysis of the case studies and progression through multiple stages of review. It will be tested through demonstration of the Black Start from DER concept in 'live trials' on SPEN networks.
- The Procurement & Compliance (P&C) workstream will address the best way to deliver the concept for customers. It will explore the options and trade-offs between competitive procurement solutions and mandated elements. It uses a strategic process to develop fit-for-purpose commercial solutions that are open and transparent, stakeholder endorsed and designed end-to-end with the commercial objectives of the project in mind. It will feed into business-as-usual activities to make changes as necessary in codes and regulations.

Keep up to date and find all other project reports **here**.

Executive Summary

This report provides a 6-monthly progress review for the Distributed ReStart Network Innovation Competition Project. Through this, it is demonstrated that Distributed ReStart is currently on schedule, on benefit and under budget.

Project Direction

The project has delivered its design stage outcomes on time and under budget. This has been achieved through an effective cycle of control processes with appropriate financial management and key quality controls in place. The careful management of finances has also enabled the project to do extra activity beyond the scope of the original NIC submission.

Planning is ongoing for the demonstration stage as the project begins live trials, desktop exercises and test procurement events to prove the designs work in practice. This will allow the project to create a single overall solution for Black Start from DER in this final project stage.

Power Engineering & Trials

The Power Engineering & Trials workstream is currently working on the planning of live testing on three case study networks – Galloway, Chapelcross and Redhouse – to help prove the concept of Black Start from DER in practice. An initial trial was undertaken on the Galloway network in October 2020 where 50km of 132kV circuit (and associated grid transformers) were successfully energised from a 11kV hydro generator. It is proposed to expand this trial to include the local 33kV distribution network (including wind farms) and energise up to the 275kV system.

The Chapelcross trial utilises a 45MW biomass generator as the 'anchor' generator with the potential being explored of incorporating wind farms connected to the distribution and transmission networks, and energisation up to 400kV. The Redhouse trial will investigate not only the ability of a 33kV connected Battery Energy Storage System (BESS) to aid the restoration process alongside a conventional synchronous generator but also its ability to energise a dead network on its own (using grid-forming technology), which is considered to be a first on GB DNO networks. The output of the trials in 2021 will be captured in a report in December 2021, 'Demonstration of Black Start from DER'.

In addition to ongoing technical study work, the PET workstream has also commissioned the prototype build of a Distribution Restoration Zone Controller (DRZ-C). In the latter part of 2021, this will be tested in a Hardware-in-the-Loop (HiL) environment at The National HVDC Centre utilising their Real Time Digital Simulator (RTDS).

Organisational Systems & Telecommunications

After delivery of all design-stage activities, the OST workstream is now focusing on three key areas central to our ambitions to demonstrate the feasibility of our proposed design specifications for the project. Firstly, our desktop exercises are based around a realistic Black-Start scenario that our participants will be able to relate to and will provide us with valuable feedback as to the effectiveness of our proposed organisational model processes. Secondly, working closely with our partners, we will share these learnings with organisational design experts, across industry as well as academia. Finally, we will work closely with the PET workstream in assessing the Cyber-Security & communications (voice & data) elements of the proposed DRZ-C restoration system that will link DERs, DNO, TO and ESO, during HiL testing.

Procurement & Compliance

Previously, the Procurement & Compliance (P&C) workstream developed a procurement approach based on open tenders for the essential 'anchor' generator and a flexible framework approach for the 'top-up' services to be taken forward for further development (please see the **P&C Report**, 'A high level outline of commercial and regulatory arrangements', for more information). This is going through further refinement, and a process map has been developed to showcase the end-to-end process. Following a detailed codes review, legal text drafting of the relevant industry codes clauses and sections is underway to feed through industry code modifications.

The next steps involve further refinement of the procurement approach, a test procurement event and contract drafting, as well as continuing to craft the specific legal text for code modifications required for Distributed ReStart. The workstream is on track to deliver the final workstream report on time.

Knowledge Dissemination

The learnings from this project will be of immense value to the industry, both locally and internationally, as energy systems continue to decarbonise and decentralise. Knowledge Dissemination plays a key role in disseminating these learnings. Effective stakeholder engagement is crucial not only for sharing key findings and challenges but also for incorporating valuable feedback into the project.

The format for this year's annual conference, was a 5-day series of Podcasts called 'The Live Trials Stage.' This included interviews with industry experts and members from the Distributed ReStart Project Team. Each Podcast is currently available to download on Spotify.

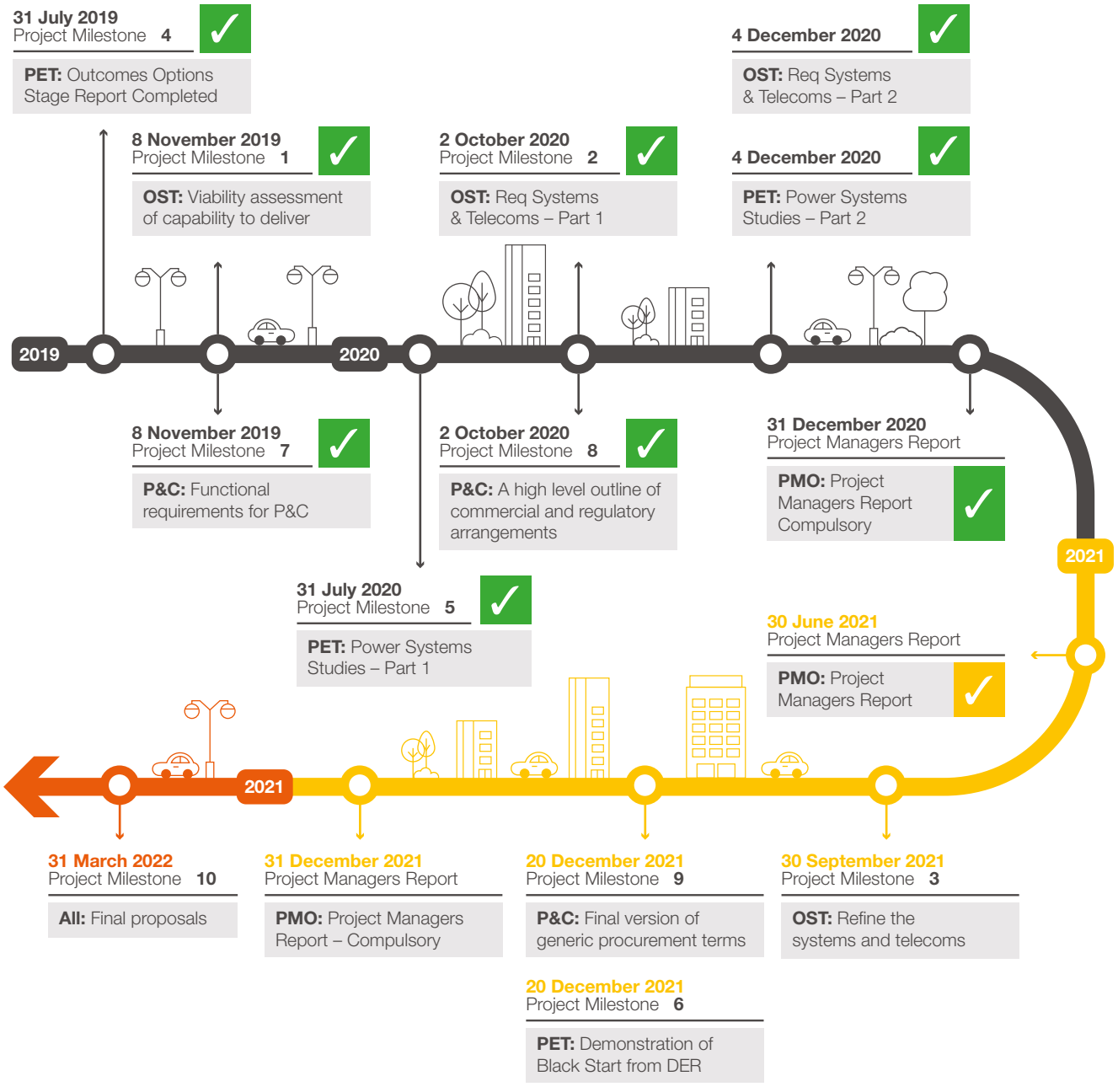
Project Governance

This project meets all governance requirements in line with the 'Electricity NIC Governance document'.

The project confirms: no intellectual property has been generated to date which has not been publicly shared; all data is either publicly available on our webpage or available on request to our mailbox: ReStart@nationalgrideso.com; and there are no material changes to project plans or outcomes from the bid submission stage. Every effort has been made to ensure the contents of this report are accurate.

Peter Chandler

Figure 1:
Distributed Restart.



Project Direction

Project delivery is highly dependent upon ensuring alignment between all workstreams, maintaining a clear direction and a project management office to hold the team to account. The Project Direction function delivers against these goals.

Key Controls

The Project Direction workstream has established and maintained a consistent approach to project management through a cycle of project controls, including:

- Monthly cost reporting from all partner companies contained in a centrally available system and detailed as far as possible against workstreams, cost categories and companies.
- Monthly finance surgeries to analyse costs incurred, verify their category allocation and review forecast costs.
- Monthly steering committee updates to senior leadership from all partner companies to scrutinise performance and action escalations.
- Weekly whole-project calls to address actions, update risks, update and mitigate any COVID-19 risks and promote awareness of whole-project outputs.
- Fortnightly workstream lead meetings to ensure alignment of all workstreams, supported by two senior engineers providing a design architect function.
- Legal review of significant contracts to ensure value is being provided to the consumer through our significant works.

This is considered adequate control to enable delivery and manage spend, progress, risks and issues.

Key Challenges

Contracting for live trials inclusive of Non-Disclosure Agreements (NDA), participation agreements, long lead item agreements and consultancy agreements has proved challenging. The project is working with a number of companies to turn around a large volume of legal agreements. The timelines for completion are difficult to predict given the number of external stakeholders involved in the process.

Table 1:
Number of legal agreements currently in progress to date:

Companies	23
NDAs progressed	23
Participation Agreements currently in progress	7

Plan & Progress

The project has successfully delivered against the full design stage bid document milestones. In addition to the mandatory project deliverable milestones, supplementary requirements documents have been published containing additional information linked to design stage outcomes and including outputs of the Distribution Restoration Zone Control System (DRZ-C) design. This includes a telecommunications and systems requirements document alongside a power engineering requirements document.

The project team followed the process of a formal industry procurement event in which we were able to award a contract to build a prototype DRZ Control System to the successful vendor. Through this tender process we accepted an offer that was 50% lower than the highest bid, demonstrating value to the end consumer.

Financial Performance

The overall project remains within budget whilst meeting all stage gate requirements. Budget out performance is currently met through a leaner resourcing structure and effective utilisation of external resources. Efficient use of external stakeholder resources has offset telecommunications review costs from the initial stage. Furthermore, extensive stakeholder engagement has opened project opportunities for low- or no-cost delivery of some required inputs.

Overall project costs are strongly linked to live trials. These costs have been forecast for both short- and long-term live trials at three locations compared with the bid document commitment to test at least two locations. Underspend to date has enabled the project to fund the third case live trial and build and test a prototype control system (DRZ-C). These two additional activities were not in the original scope of the NIC bid document but are value-added activities which will enhance the learning output from this project.

Quality Assurance

The project has established a stakeholder advisory panel consisting of independent experts from across the electricity industry to scrutinise the outputs of the project. This provides independent quality assurance and raises points for investigation in later outputs. In addition, the project also includes a Design Architect function where our technical experts can review and challenge new proposals and examine output from the workstreams. Furthermore, webinars, email promotional campaigns, a virtual project conference event and presentations at external industry events has enabled public commentary on outputs.

A full record of this engagement is available on our webpage:

Power Engineering & Trials

The technical capability to deliver Black Start using DER is assessed through the Power Engineering & Trials workstream. The outcomes are detailed technical specifications supported by live trials in 2021/22.

Workstream Summary

The Power Engineering & Trials workstream is currently in the demonstration phase of the project, with the output at this stage being a report detailing the outcomes and learning from the live trials completed in 2021. This will be entitled 'Demonstration of Black Start from DER' (due to be published by 20 December 2021).

The workstream is on track to deliver multiple live trials on three separate case-study networks.

Live Trials

Three case studies (sample areas of the SP D and SP Transmission networks) have been selected to progress to the live testing stage. These are:

1. Galloway case study, south-west Scotland – a 11kV hydro generator will be the 'anchor' (used to initially energise the network).

   Testing is planned to include the associated 132kV and 275kV transmission networks, along with the local 33kV distribution network (including wind farms). In October 2020, an initial trial was undertaken in this area where the hydro generator simultaneously energised 50km of 132kV overhead line and two grid transformers. Two test periods are planned in the second half of 2021 (each several days).

2. Chapelcross case study, south-west Scotland – a 45MW biomass generator will be the anchor.

   Testing is planned to energise the local distribution and transmission networks (up to 400kV) and to incorporate wind farms connected at both distribution and transmission voltage levels. One five-day test period is being planned to take place in April/May 2022.

3. Redhouse case study, Fife, Scotland – a 11MVA BESS will be the anchor (grid-forming technology will be installed).

   Testing is planned to investigate how a BESS may best be utilised to aid the restoration process of the distribution and transmission networks alongside a conventional synchronous generator (a 33kV connected diesel generator will be used for testing purposes). In addition, this BESS will be equipped with grid-forming technology (able to create its own independent voltage source). As such, the ability of the BESS to energise the network on its own (the role of the anchor generator) will be tested. This is considered to be the first time that a 33kV grid-forming BESS will be trialled on a GB DNO network. Significant learning is expected to inform the future utilisation of this emerging technology.

   Two five-day test periods are being planned (the first on the BESS site 33kV network and the second incorporating the wider distribution and transmission networks). At present, these are scheduled for August and September 2021 respectively.

Additional Work

In parallel with the live trial planning work, the PET workstream has also commissioned to develop and test a prototype of a DRZ Controller (the automation required to overcome the technical and human resource challenges to facilitate Black Start from DER). This work follows on from the functional specifications for a DRZ-C which were developed by four technology companies in 2020. Factory acceptance testing (FAT) will be undertaken within the vendor's own laboratory test environment. Further testing will be carried out at The National HVDC Centre, where the DRZ-C will be tested in a HiL environment using a model of the Chapelcross case study distribution and transmission networks (which have been built on the RTDS).

In addition, the PET workstream is progressing relevant study work to enhance the overall technical learning to achieve Black Start from DER. This includes:

- Development of functional requirements for DER to provide the service of an anchor generator and 'Top Up' services (e.g. voltage control, short circuit level and inertia).
- Commissioning of a report on the 'Technical and Resiliency Review of Wind, Solar and BESS Developments' to understand the existing capability of DER to provide the proposed Top Up services.
- Commissioning of a report on transformer energisation from grid-forming converters (RTDS testing relating to this is planned at the Power Networks Demonstration Centre [PNDC] in Quarter 3, 2021).
- Commissioning of a report on the protection performance, and potential modifications, when the anchor generator is a grid-forming converter (the fault infeed is typically the same as full load current thus making it difficult for traditional protections to distinguish between load and fault currents).

Key Workstream Findings

Galloway Case Study Live Trial (October 2020)

The first project live trial was undertaken in October 2020 on the Galloway case study network, where an 11kV hydro generator was used to energise 50km of 132kV overhead line simultaneously with a 132/33kV and a 132/11kV transformer.

The key findings form this trial were:

1. Transient Over Voltages (TOV) caused the generator to trip (on its over-voltage protection) when attempting to energise the test circuit. This was due to the transformer inrush currents (rich in harmonics) forming a resonant circuit with the network resulting in TOV. This is most likely to be an issue when energising transformers and circuits simultaneously.
2. Fine tuning of network models is required (particularly transformer saturation) to accurately predict any TOV issues.
3. Successful energisation was achieved using a Point on Wave (PoW) relay which times the closing of the DNO energising circuit breaker to minimise the transformer inrush currents, and thus the peak voltages on the network. This was a timely and innovative inclusion in this project as these relays are not typically used on DNO networks. The testing showed that they may have to be installed more widely in the future for Black Start from DER purposes.
4. The capability of the distribution switchgear needs to be assessed to ensure that it is adequate for the non-standard network operation to which it is subjected. For example, not all switchgear types are capable of breaking very low fault currents or breaking the charging current associated with de-energising an islanded network.

Live Trial Development and Implementation Works

In order to facilitate the live trials on the network there are a number of preparatory works that have to be undertaken. For the proposed three live trial sites, the works currently include:

- Feasibility assessment of the anchor generator to assess its capability and requirements for 'island mode' operation.
- Protection assessments of the case study networks and DER installations to identify changes required with reduced fault levels when in island mode operation.
- Building network models of the case studies and carrying out steady state, dynamic and transient studies to identify any potential issues such as TOV or circuit breakers being asked to perform duties outside their design capabilities.
- Hiring of load banks, diesel generation and earthing transformers (to be connected at 33kV) to be incorporated in the test scenarios.
- Purchase and installation of switchgear to allow temporary equipment to connect.
- Development of step-by-step test plans for each trial in conjunction with the relevant DER operators and DNO responsible persons.
- Ensuring there are fault recorders at the appropriate network locations so that all data can be recorded and analysed after each relevant step of a test programme.

Conclusions

- The initial Galloway live trial has already provided significant learning which is now being incorporated into the development of the subsequent trials.
- With the DER and DNO networks not being designed for Black Start (islanded) operation, there is a variety of study works needed to determine the requirements for safe operation and works to implement the required changes.

Workstream Delivery

The PET workstream is on track to deliver the December report to meet the criteria outlined in Table 2:

Table 2:
PET demonstration stage successful delivery criteria

Delivery Criteria	Status	Action
Report 'Demonstration of Black Start from DER'	Ongoing	One live trial has already been completed (Galloway, October 2020) and a further five separate trial periods are currently planned across three case study networks (~20 days testing in total).
Detail the outcomes and learning from the trials	Ongoing	The results and learning from the individual trials will be recorded and collated in the PET December 2021 report. Chapelcross trial results will be published with the project closedown report in June 2022.
Assess against the testing objectives specified for the trials	Ongoing	For each live trial a step-by-step test plan will be created detailing the objectives for each individual test. The results will then be assessed accordingly.
Use a stakeholder-led approach	Ongoing	By nature of the critical involvement of the DER (especially the anchor generators), the DER are significantly involved in detailing the requirements for their own site, and the wider network tests which they will enable.

Workstream Technical Challenges

A summary of the biggest challenges expected to be resolved through the demonstration stage of the PET workstream is given in Table 3:

Table 3:
Key PET workstream challenges and mitigating actions

Challenge	Current supporting activities
Ensure that the live trials result in no damage to the DNO, TO or DER equipment.	System studies will be undertaken for all trials as appropriate to identify any potential issues (e.g. over voltages).
For the live trials, the low fault levels may inhibit the connection of converter connected DER (e.g. wind farms).	Early engagement has been initiated with the turbine owners of the wind farms within the trial sites. Mitigation options have been identified such as limiting the number of turbines in a test.
De-risk the live trials such that the maximum testing and learning is obtained.	Where practical, the trials will be carried out to ensure initial stages are completed before wider network tests are attempted. For example, Redhouse and Galloway case studies will be trialled in two incremental stages.
Ensure that future restoration solutions do not always require a synchronous generator as the anchor generator in a DRZ.	In the Redhouse trial, a grid-forming converter connected BESS has been commissioned to test to what extent it can provide the same benefit as a synchronous anchor generator.
Ensure that the Distributed ReStart project remains open to emerging technologies providing the required technical services.	In the Redhouse case study trial, grid-forming technology will be installed on the BESS converter, and the ability of this to energise a dead network (as per a traditional synchronous anchor DER) will be tested.

Workstream Plan

Table 4:
Workstream delivery plan for PET

Activities	Target Date
Galloway Phase 1 & 2 Live Trials	August & September 2021
Redhouse Phase 1 & 2 Live Trials	August & September 2021
Factory Acceptance Testing (FAT) of DRZ-C	November 2021
Report – Demonstration of Black Start from DER	December 2021
DRZ-C Report: Findings to be published on web with an Executive Summary	February 2022
Chapelcross Live Trial	May 2022

Organisational Systems & Telecommunications

Delivering the restoration process will be dependent upon the capabilities of the organisations involved, their teams, processes, systems and secure operational telecommunications. These areas are being developed through the Organisational Systems & Telecommunications workstream.

Workstream Summary

The Organisational Systems and Telecommunications workstream (OST) is heavily focused on preparation for the upcoming desktop exercises, where we will be utilising a simulation tool developed by our partners TNEI. This 'Proof-of-Concept' tool will allow us to demonstrate a DER-led restoration scenario, using the Chapelcross case study, engaging control engineers to work through the restoration script, and will also provide the project immensely valuable feedback and learnings. In addition, we are working with the PET workstream on the further development of the DRZ Controller, including an integration plan and consultation on the functional requirements for operational telecommunications.

The workstream is on track for delivery of the desktop exercises outcomes, system designs and recommendations.

This will allow the project to demonstrate capability to conduct a Black Start using DER with tested processes and system integration proposals, alongside costed options for delivery of the required communications channels and protocols. All of this will be included in the September 2021 report (OST: Refine the systems and telecoms report), along with insights on our proposed organisational model processes and procedures from external organisational-design experts.

Key Workstream Findings

Organisations

The project has further developed and consulted on the proposed 'organisational model' determining the roles, responsibilities and procedures necessary to effectively restore the network.

In this model, NGESO remains responsible for coordinating the national and regional restoration approach, but the licence area DNO is delegated the role of frequency leader and is responsible for local restoration strategy within a Distribution Restoration Zone. This new capability requirement for a DNO acting as a distribution system operator is enabled by a DRZ-C to manage the dynamic behaviour and DER dispatch with control engineer focus on directing the restoration strategy and approving batch processes.

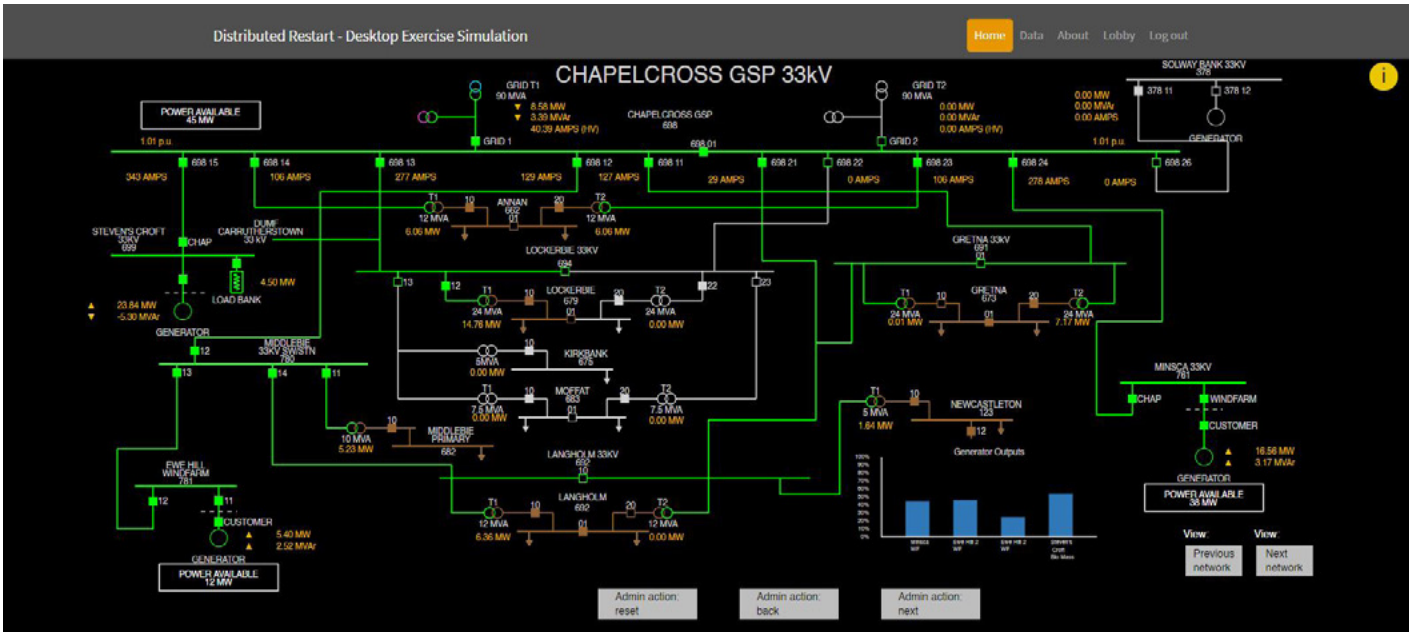
In order to test the efficacy of the approach, a custom web-based restoration simulation of the Chapelcross Network area has been developed and is being tested through a series of desktop exercises running from the end of May to early July 2021. The key dates are:

- Thursday 27th May – Completed
- Tuesday 8th June – Completed
- Tuesday 6th July

The key objective of these exercises is to test the communication interfaces, roles & responsibilities, visibility requirements and sequence of actions (as designed) in order to:

- identify improvements to the initial designs, and:
- validate our proposed command & control structure for a bottom-up restoration from DER.

Figure 2:
Desktop Exercise Simulation Dashboard



The dates for these exercises have been chosen to maximise the involvement of key roles who would be involved in the bottom-up restoration, as well as give a wide audience of interested stakeholders the chance to observe the process and be able to provide immediate feedback during the breakout sessions at the end of each exercise.

In terms of the methodology we are employing, each half-day will start with an introduction session to the restoration tool, objectives & requested feedback methods. Use will be made of multi-media and digital techniques to maximise the main points that participants need to know. Participants will then run through the exercise themselves, making operational decisions & providing feedback & challenges to project team.

Success Criteria

Across desktop exercises we aim to deliver against the following objectives:

- Representation from all DNOs, TOs, ESO and a good cross section of DERs.
- Capture and implement improvements to operational procedures and supporting documentation.
- Complete a continuous improvement stage between desktop exercises.
- The consolidated learnings from these exercises will inform future training requirements and identify improvements to the proposed organisational design. The newly formed Engineering Advisory Council (EAC) will be asked to review and comment on our organisational design. This council is made up of engineering experts across industry and academia.

Operational Telecommunications

A functional specification for operational telecommunications delivered through the Design Stage II report is being reviewed as the DRZ-C design work progresses. The functional specification – technical requirements, general requirements, bandwidth requirements, supported protocols and cyber security considerations – will be compared against the outputs of the detailed DRZ-C design work and refined where changes have been identified.

Operational Systems

DER capabilities.

A report on technical and resilience capabilities of existing DER to provide Black Start services has been delivered. This report summarises the capabilities and limitations of control and communications systems used for wind, solar, BESS and synchronous thermal generation. The information relates to the current and future control systems and communication interface with the DNO. These were gathered through discussions with subject-matter experts and DER owners/operators. This report will be available on the Project website Feb 2022.

The report includes typical communication and resilience capabilities based on their connection topology, intrinsic capabilities and associated plant installed alongside each technology.

Two case study types for thermal installations which included a steam-based and engine-based generation were reviewed.

The report has provided the project with existing and future capabilities of power supply resilience, and control and monitoring facilities.

DRZ-C Design and Cyber Security Assessment:
The OST workstream in collaboration with the PET workstream is working on two key strands as part of the refinement of the Cyber-Security and resilient power and telecoms designs, highlighted in our December Stage II report.

Firstly, detailed work on the design of the Distributed Restoration-Zone Controller (DRZ-C) with our chosen supplier has commenced. This will involve developing the detailed design of a DRZ-C solution, followed by its implementation and test, as detailed in table 5 below. The outcome of this exercise will describe the resilience of the proposed design and its reliance on other systems, particularly power supplies and telecoms. Secondly, a cyber security assessment is being carried out alongside the DRZ-C design. This will investigate the Communication Resiliency, Security Strategy and Design for potential Distributed ReStart participants' Operational Telecommunications (OT) networks and systems interfacing with power infrastructure and hardware.

The Cyber Security assessment is currently ongoing and due to be delivered by the end of November 2021 in two phases:

- Phase 1 – The Requirement phase, will deliver a series of reports, highlighting best practice for communications strategies and cyber-resilience for multi-party Power Systems and Industrial Control Systems, along with Communication, Network and High-Level Data and end-to-end System Requirements. In addition, it will set out options for Disaster Recovery Systems.
- Phase 2 – The Design phase intends to deliver Designs for the Communication, Network and Data Systems, as well as setting out the communications strategies that will complement the Designed Systems. In addition, we expect to receive detailed designs of selected Disaster Recovery options and estimated implementation and running costs of the Designed Systems.

The key to the above will be the simulation & testing of all our designs, strategies & assumptions, as detailed in Table 7.

Workstream Delivery

The Organisational, Systems and Telecommunications workstream has delivered against all design stage requirements and is now in the refine stage, and the next deliverables are shown below in Table 5:

Table 5:
OST refine stage successful delivery criteria

Delivery Criteria	Status	Action
Undertake a desktop exercise to test the organisational capability for the process including systems and telecommunications	Ongoing	3 exercises, making use of an online simulated control environment, will be used to identify improvements with representation from key organisations across GB.
Capture learnings from the exercise within an update to the Key Deliverable 2 report.	Planned	Delivery planned for 30/09/21.
Working with manufacturers to complete designs of systems and telecommunications required for Distributed Restart.	Ongoing	A design for a DRZ-C is ongoing inclusive of a cyber security work package to ensure a full end-to-end solution is proposed.
Where appropriate, undertake offline tests to prove capability of systems via Hardware-in-the-Loop testing.	Planned	Hardware-in-the-Loop tests of the DRZ-C system are planned at The National HVDC Centre. Planned for November-December 2021.

Workstream Technical Challenges

Table 6:
Challenges for the OST workstream

Challenge	Current supporting activities
There is not a consistent operational communications or system interface with DER	A review has been conducted covering both asynchronous and synchronous energy resources with the findings built into process design and operational communication proposals.
Wider industry changes could impact on systems and Black Start participants' responsibilities	Continual engagement with wider industry projects and initiatives including Strategic Telecoms Group (STG), Energy Networks Association (ENA) Open Networks and Europe Utility Technology Council (EUTC).
DER do not currently participate in Black Start, so new processes and training will be required.	Desktop exercises will provide a model for training and refine overall process design and are planned to include representation from all key stakeholder groups.
Provision of cyber secure end-to-end Operational Telecommunications	A detailed cyber security analysis and specification will be produced as part of ongoing DRZ-C work.

Workstream Plan

The high-level delivery plan for the refine stage of OST is provided in the table below.

Table 7:
Organisational Systems & Telecommunications refine stage plan

Activities	Target Date
Desktop exercises	May – July 2021
September OST Report on desktop exercises	30 September 2021
DRZ-C design and build	November 2021
DRZ-C cyber-security analysis	November 2021
Hardware-in-the-Loop testing of the DRZ-C	December 2021
Post-September Report telecoms refinement (DRZ-C related)	February 2022
Input into project closure report	March 2022

Anticipated Change Requirements

Organisational change requirements are limited to the roles, responsibilities and training requirements with introduction of the DRZ-C system limiting the need for additional control engineers on site.

Resilient and cyber-secure communications between DER and DNO are required to facilitate Distributed ReStart. These must be upgraded or replaced to meet the functional specification and include power resilience.

Procurement & Compliance

A key aspect of this project is to develop a viable route to market that ensures value for end consumers through transparency, competition and increased participation. The aim of the workstream is to develop a fit-for-purpose, stakeholder endorsed, end-to-end process that meets the commercial objectives of the project.

Workstream Summary

The Procurement & Compliance (P&C) workstream is currently in the refine stage.

The workstream is on track to deliver its final workstream report by 20 December 2021.

The longer-term goals of the workstream are to refine developed proposals for the procurement process and commercial structures that create a route to market for a future Black Start service from DER, which will be enabled through proposed code changes. Proposals and approaches developed by the workstream will be refined by engaging with industry stakeholders.

Workstream Outputs

The outputs from the design stage included a proposed procurement approach which the workstream is in the process of refining to ensure it is fit for purpose, stakeholder endorsed and meets the commercial objectives of the project.

Following a detailed and comprehensive examination of specific codes and clauses previously, detailed legal text drafting is in progress on the Grid Code and Distribution Code.

Procurement

The strategy development process involves five stages:

- objectives
- inputs and Analysis
- initiatives
- refine
- implement.

The design stage focused on refining the Objectives and Inputs and Analysis, through stakeholder engagement, and developing Initiatives. The refine stage of the project focuses on the Refinement of the developed initiatives, as well as developing the route for Implementation.

The approach taken forward from the design stage was 'approach two', as it provided the most flexibility for the procuring entity around the specific design of the service, and it also offered the lowest barriers to entry for potential providers.

In approach two, the party responsible for procurement contracts for all of the required elements of a DRZ with whichever parties create the best value proposition and can hold one or multiple contracts per DRZ. The procuring entity would contract with the anchor generator and top-up services separately (as required). The top-up services could be procured in different combinations (individually, all together or a combination of the two).

A process map has been designed to understand the end-to-end process for the proposed procurement approach ('approach two'). This will be tested with stakeholders to gather their views and ensure the process is stakeholder endorsed, to find out more about our recent stakeholder webinar, **please visit our website** where the information shared and recordings are available.

The process map will be used for designing the test procurement event and the solution which will be implemented once the project has finished.

Collaboration between the PET workstream and the P&C workstream on designing the required elements of the procurement process is underway. The functional requirements, 'rules of play' between anchor generators and top-up services, and the assessment criteria are being tested with stakeholders and refined further to feed into the development of contractual terms and obligations on the different parties.

Codes

A detailed and comprehensive review of the industry policies, regulations, codes and standards was carried out in the P&C report, a "high-level outline of commercial and regulatory arrangements"; the specific sections and clauses where codes will need to be changed or adapted to enable a Distributed ReStart were highlighted.

The main industry codes that will require changes are the Grid Code and Distribution Code including G99, where operational, contractual and engineering elements of the Distributed ReStart process will need to be added into the codes. The Connection & Use of System Code (CUSC), BSC (Balancing and Settlement Code) and DCUSA (Distribution Connection and Use of System Agreement), will also need to be considered dependent on the design of settlement and funding for Distributed ReStart. There are continuing dependencies on the PET, OST and P&C workstreams for the input to the codes work.

Input to, and refinement of, legal code text drafting is continuing to be progressed through NGESO and SPEN code change teams, with extra support from the Energy Networks Association (ENA) and Cornwall Insight.
The project is continuing engagement with the Emergency and Restoration Phase II workgroup (which aligns to the Distributed ReStart project).

Conclusions, Next Steps and Dependencies

Stakeholder engagement was key to the development of the procurement approaches and commercial structures; this has continued as P&C moved into the refine stage of the project.

The next steps for P&C involve continued refining of the recommended procurement approach and beginning to define the contract principles and draft contract terms. The next steps for the codes work involve feeding into the Emergency and Restoration Phase II workgroup and continuing to craft the specific code modifications required for Distributed ReStart.

There are still several key enablers and dependencies across the project, including using the test procurement event to test the procurement approach, understanding the full costs involved in providing a Black Start from DER service and design of the operational structure of the service to feed into the development of contract terms.

Workstream Delivery

Table 8 outlines the 2021 Procurement & Compliance workstream report's objectives.

Table 8:
Successful Delivery Criteria for P&C refine stage

Delivery Criteria	Status	Action
Generic standard terms of contract by which a service for Black Start could be procured reflecting industry engagement.	Under development	The project will begin to develop the generic standard terms of contract for a Black Start from DER service.
Outline the contractual obligations on each party required in the delivery of the service and the necessary commercial arrangements.	Under development, with dependencies on the other workstreams	The project will begin to develop the contract principles and structures to support drafting the contracts, subject to dependencies. Alongside contract drafting, design of the settlement and funding of a future Black Start from DER service is underway.
Regulatory and funding arrangements	Under development, engagement with relevant parties is being sought	Conversations with DNOs and other relevant parties are being planned, to understand potential funding and licence changes required.
Required changes to codes and licence requirements	Under development	Refinement of required code changes is in progress.

Delivery Challenges

There are a number of key challenges for the workstream:

- There are dependencies on PET and OST workstream outputs for developing the contract principles and drafting contractual terms. This risk to timelines is being managed carefully through whole project planning as well as challenge and support from project design architects.
- Organising and running a successful test procurement event will inform the refinement of the procurement approach and contract drafting.
- In the initial stages of a potential roll-out, it is likely to require a phased implementation because there is a high likelihood that processes will be manual, there will be a necessity to test and learn from any processes and there needs to be availability and readiness of DER to participate.

Workstream Plan

Table 9:
Procurement & Compliance workstream plan

Activities	Target Date
Industry stakeholder engagement	Ongoing
Engagement with PET and OST to address dependencies	Ongoing
Refinement of the recommended procurement approach	July 2021
Design and delivery of a test procurement event subject to dependencies	August/September 2021
Development of contract principles to support contract drafting	November 2021
Development of code change proposals and input to relevant code modification workgroups	October 2021

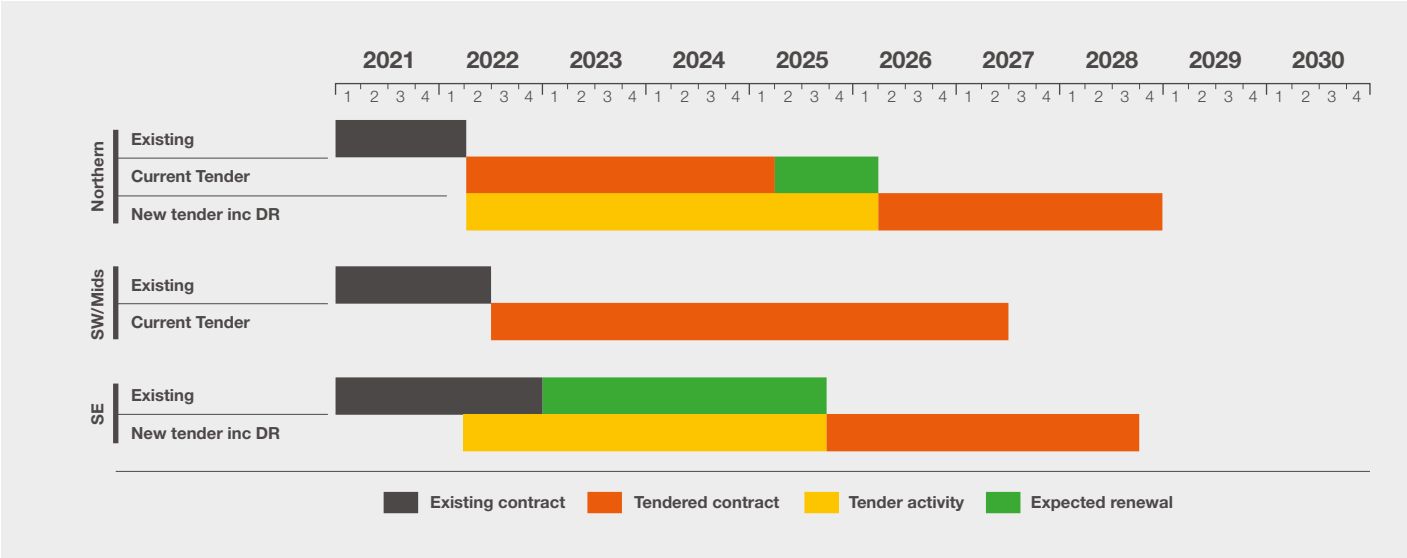
Anticipated Change Requirements

The commercial contracts and structures will be developed subject to dependencies over the course of the project. Any licence condition or code change requirements will continue to be determined throughout the refine stage with support from internal NGESO and SPEN code experts.

Through continued development and iteration, and in line with the inputs considered within the design stage (including stakeholder engagement and updated project assumptions), it has been possible to propose a roll-out option which aligns with the ESO's current procurement of Black Start services.

The ESO submitted its Black Start Strategy and Procurement Methodology for industry consultation in March with subsequent submission to Ofgem at the beginning of April. This included an outline of how the ESO expects the Distributed ReStart service procurement could align with the current ESO Black Start tenders.

Figure 3:
Proposed rollout into Business As Usual (BAU)



Knowledge Dissemination

All workstreams have relied on a stakeholder-led approach to uncovering challenges, establishing existing capabilities and developing future options. This approach has been facilitated through the Knowledge Dissemination workstream.

Figure 4:
Distributed ReStart podcast teaser campaign

Stakeholder Analysis

Knowledge and Dissemination plays a key role in disseminating project learnings to a variety of stakeholders ranging from DER and network operators through to academics, policy makers and end consumers.

Effective stakeholder engagement is crucial not only for sharing key findings and challenges but also for incorporating valuable feedback into the project.

The project is now able to monitor and track via statistical analysis our findings through:

- regular engagement with our stakeholders, building relationships and ensuring constructive feedback to inform the project, future events and communications
- key channels including email campaigns, social media, events and webinars
- constantly monitoring the performance of our communications using email and web analytics
- our email database allowing us to identify and target stakeholder segments to meet their specific needs and interests, e.g. DNO/TO workshops and workstream promotions
- interactive events and workshops enabling stakeholders to ask questions and have panel discussions with senior project members and industry experts
- creative and engaging content that meets 'best practice' for digital communications guidance
- messaging and identity branding needed to reflect the importance of the project as a world first initiative
- email campaigns providing clearer customer journeys, using subject lines and layouts to ensure maximum openings and clicks
- utilising social media to convey strong creative executions to drive response and grow audiences.

On our webpage you will find an animation, high-level description of project outputs and the project infographic explaining current and potential future Black Start processes.

Engagement Activities

We have an active distribution list of over 720 registered interested parties and use this as a channel to engage with people globally through 'lightbulb moment' email updates, sharing pertinent project information and news, webinars discussing specific project deliverables and challenges, and to promote attendance at specific industry events.

Examples of our key engagement activities are shown in Table 10.

Figure 5:
Stakeholder Campaigns, demonstrates the reach and success of the campaign.

THE LIVE TRIALS STAGE PODCAST DASHBOARD

A 5-day podcast event 12–16 April 2021

Owner Emma Penhaligon – Knowledge and Dissemination Lead
Peter Chandler – Project Lead

E-mail Registration Campaign

Teaser and registration emails

31% Email open rate*

18% Global average open rate

25% Email click rate**

14% Global average click rate

* Calculated by number of unique email opens divided by number of emails delivered.

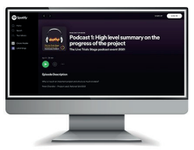
** Calculated by number of unique clicks divided by number of emails delivered (CTR).

Global average email data 2021 supplied by **Campaignmonitor.com**

'Unique email opens' means if a recipient opens an email five times, it will still only count as one unique open. The same applies to 'unique clicks' on links in the email.

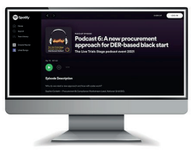
The Podcast Event Webpage

381 pageviews



Average time on page

5.17 minutes



220 on page clicks

Feedback

> **Surprisingly good. Informative and interesting in equal measure. The Panel session with Messrs Openshaw, Scott and Jenkins was very good.**
>
> – Mike Kay, P2 Analysis Ltd

The 5-Day Podcast Event

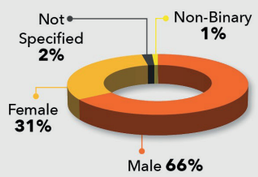
The 6 podcasts were professionally produced and recorded remotely. They were hosted on BuzzSprout and published on Spotify. Data accurate as at 23 May 2021 and figures have been rounded up.

Participants: 14

Participants located in:

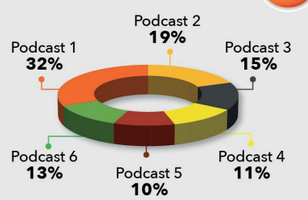
England | Scotland | Isle of Wight

Streams by Gender



Downloads by podcast

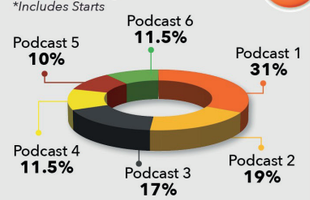
Total 501



Streams by Podcast

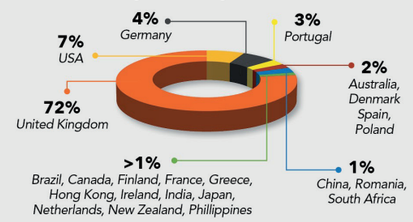
Total 378

*Includes Starts

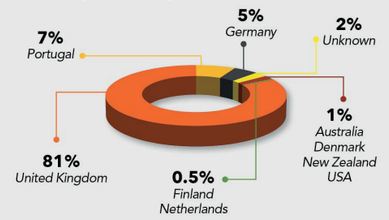


Downloads by Country

Total 501



Streams by Country



Distributed ReStart

Energy restoration for tomorrow

The Distributed ReStart project is now entering its most challenging and exciting phase – The Live Trials Stage. This stage involves testing the proposed designs at live network trials and with desktop exercises.

This year's Distributed ReStart annual event was delivered via a series of podcasts. 'The Live Trials Stage', followed on from last year's conference, 'The Design Stage'. The podcasts were designed to incorporate all the workstream leads and to present our journey through a series of challenging questions. Giving the audience the opportunity to download and listen at a time that was convenient for them.

The podcasts remain hosted on Spotify and the main webpage, for people to download.

The hosting and interviewing were carried out by people independent of the core project and externally employed. Hosting was Trisha Lewis an actor, facilitator, business coach and podcast host with experience as a professional performer and speaker.

Interviewing was Simon Harrison, a member of the project's Stakeholder Advisory Panel and is Group Strategic Development Director at Mott MacDonald.

The podcast dashboard details the whole campaign including email campaign, podcast statistics, webpage analytics and customer feedback.

The agenda consisted of the following:

Monday 12/04/2021	
Podcast 1: High level summary on the progress of the project Why is it such an important project and why is so much at stake?	**Listen here**
Podcast 2: To explore the role of design architects in the project How design architecture works, the assumptions, trade-offs and choices made.	**Listen here**
Tuesday 13/04/2021	
Podcast 3: Panel discussion with external industry experts Distinguished external experts holding the project to account in all areas.	**Listen here**
Wednesday 14/04/2021	
Podcast 4: The Live Trials – latest developments and progress An exploration of the latest findings and possibilities for a future roll-out.	**Listen here**
Thursday 15/04/2021	
Podcast 5: Technical and cyber challenges for systems and telecoms Unpacking the cyber-challenge and how to ensure system resilience.	**Listen here**
Friday 16/04/2021	
Podcast 6: A new procurement approach for DER-based black start Why do we need a new approach and how will codes work?	**Listen here**

Table 10:
Engagement activities

Event	Value Unlocked
'Black Start from DER' by Vahan Gevorgian, Chief Engineer, NREL, on 30 March 2021 as part of the Energy Systems Integration Group (ESIG) Spring Workshop: Session 9: Distribution System Planning Evolution.	This presentation described recent research by the National Renewable Energy Laboratory on how restoration services can be provided by DER including inverter-based resources.
SGN/OpTel/Black Start BAU – Roger Crane & Christopher Thompson – Discussion with Black Start BAU, National Grid OpTel and SGN on the need for communication between gas network operations and DNOs during/immediately after restoration for resilience and security of supply purposes.	Distributed Restart project will highlight this requirement for consideration in the communication plan. The NGESO Black Start team will raise the issue of notification of gas network operators and resilience with BEIS for the current Black Start restoration.
ENA Open Networks Project	Distributed Restart engagement with other programmes in NGESO- Network Control programme and Regional Development Programmes to identify shared areas of interest – data exchange and situational awareness.
Annual Conference – Podcast Series – The Live Trials Stage	Distributed Restart's annual event, 'The Live Trials Stage', which follows on from last year's conference, 'The Design Stage'. This year, the event took the form of a 5-day series of podcasts. The podcasts included in-depth interviews and a lively panel discussion with external industry experts. Each day during the week commencing 12 April 2021 a podcast (30-45min) launched including an overview from Peter Chandler, the Project Lead.
DER Event 20th May 2021	Potential DER providers of a black start services were invited to input into our procurement process. The webinar included presentations by the project leads followed by a full Q&A session giving the opportunity to feedback. The session covered: • Procurement process – an end-to-end process map. • Functional requirements – suggested technical requirements for providing a black start service from DERs. • 'Rules of Play' – the rules of play used for understanding whether a feasible Distribution Restoration Zone (DRZ) can be created. • Proposed Connection and Use of System Code (CUSC) and Grid Code status.
Desktop Exercises 27th May 2021 08th June 2021 6th July 2021	The desktop exercises are being conducted virtually and make use of an emulation platform to simulate a black start restoration procedure. Candidates were presented with different scenarios that tested operational processes and communications structures including the roles of key personnel in the restoration process. The exercises were designed to be informative and provide an opportunity to co-develop the process.

Targeted Stakeholder Review & Challenge

The project has taken part in numerous targeted industry consultations inclusive of membership of working groups and hosting workshops. This allows direct input to project deliverables drawing on knowledge of subject matter experts inclusive of rigorous challenge.

Table 11:
Table of specific industry consultation activities

Event	Value Unlocked
Strategic Telecoms Group **Ongoing collaboration**	Ongoing working group. Direct input and challenge to the telecommunications functional requirements, ensuring representative views from network operators across GB.
Knowledge sharing with Resilience as a Service NIC project **Ongoing collaboration**	Ongoing engagement in line with agreement with Ofgem. Now a member of the project stakeholder advisory panel.
European Utility Technology Council EUTC knowledge share **Ongoing collaboration**	Article on OST developments in the EUTC April newsletter with ongoing operational telecommunications input based on Europe-wide developments.
Imperial College and SMPN Networks engagement	Quarterly calls on operational telecommunications and cyber security.
E3CC meetings	Ongoing feedback including presentations.
BEAMA **Ongoing collaboration**	Ongoing engagement with the UK trade association for manufacturers and providers of energy infrastructure technologies and systems.
ENIC formerly LCNI **October 2021**	ENIC is the UK's flagship knowledge dissemination event for the electricity and gas energy network operators. It offers a single platform where delegates can access the major learnings from the largest regulator-funded innovation projects in the country – Network Innovation Competition (NIC) and Network Innovation Allowance (NIA).
Utility Week Live **Stakeholder collaboration & review Q3 September 2021**	Utility Week and NGESO propose to partner to conduct a timely review of stakeholder hopes and expectations for innovation roll-out on the back of the project.

Email Campaigns

As more reliance falls upon digital comms and virtual interactions, the need to evaluate and benchmark our delivery will become greater. People's expectations are growing at a rapid rate due to the pickup of this format during the pandemic. The information below shows a graphical representation of the volume and success rates associated our email campaigns.

Table 12:
Summary of stakeholder engagement activity

Summary December 2019 – April 2021	Statistics
Campaigns	49
Emails	24,751
Delivery Rate	99.50%
Bounce Rate	0.50%
Open Rate	40%
Click Rate	38%
Engagement	
Active	34%
Inactive	66%
Segmentation	
DNO/TO	7%
Industry Experts	27%
Stakeholders	66%

Planned Future Engagement

Throughout the design stage of the project, stakeholder input has been key to building on existing knowledge and ensuring an inclusive solution. The team commits to continue attending and hosting events throughout 2021. Table 13 details our planned engagement, but this will be continually revised and added to throughout the project.

We have taken into consideration the impact of COVID-19 upon the project and its ability to interact in open forums. We have developed a virtual event format which we intend to continue which will carry on offering opportunities for knowledge sharing alongside one-on-one interactions.

Table 13:
Planned stakeholder events

Event	Date
Stakeholder Advisory Panel	Ongoing via teleconferencing
Strategic Telecommunications Group	Ongoing via teleconferencing
CIGRE Black Start working group	Ongoing via teleconferencing

Knowledge Sharing

As a project team, it is important to us that all stakeholders are listened to and the knowledge gained from an interaction is passed on to everyone. If this report has prompted any questions of your own, email us at **ReStart@nationalgrideso.com**

Project Governance

Data Access

Every effort is made to disseminate all project learnings through **our webpage**:

Should any further information be required, such as access to raw data, this may be requested subject to conditions on background IP. This request should be sent to: **ReStart@nationalgrideso.com**

Intellectual Property

No specific intellectual property has been developed which has not been shared openly in reports at this time.

Contracts with third parties are structured so that their background intellectual property is protected but the project can share findings on designs and solutions proposed for Black Start from DER.

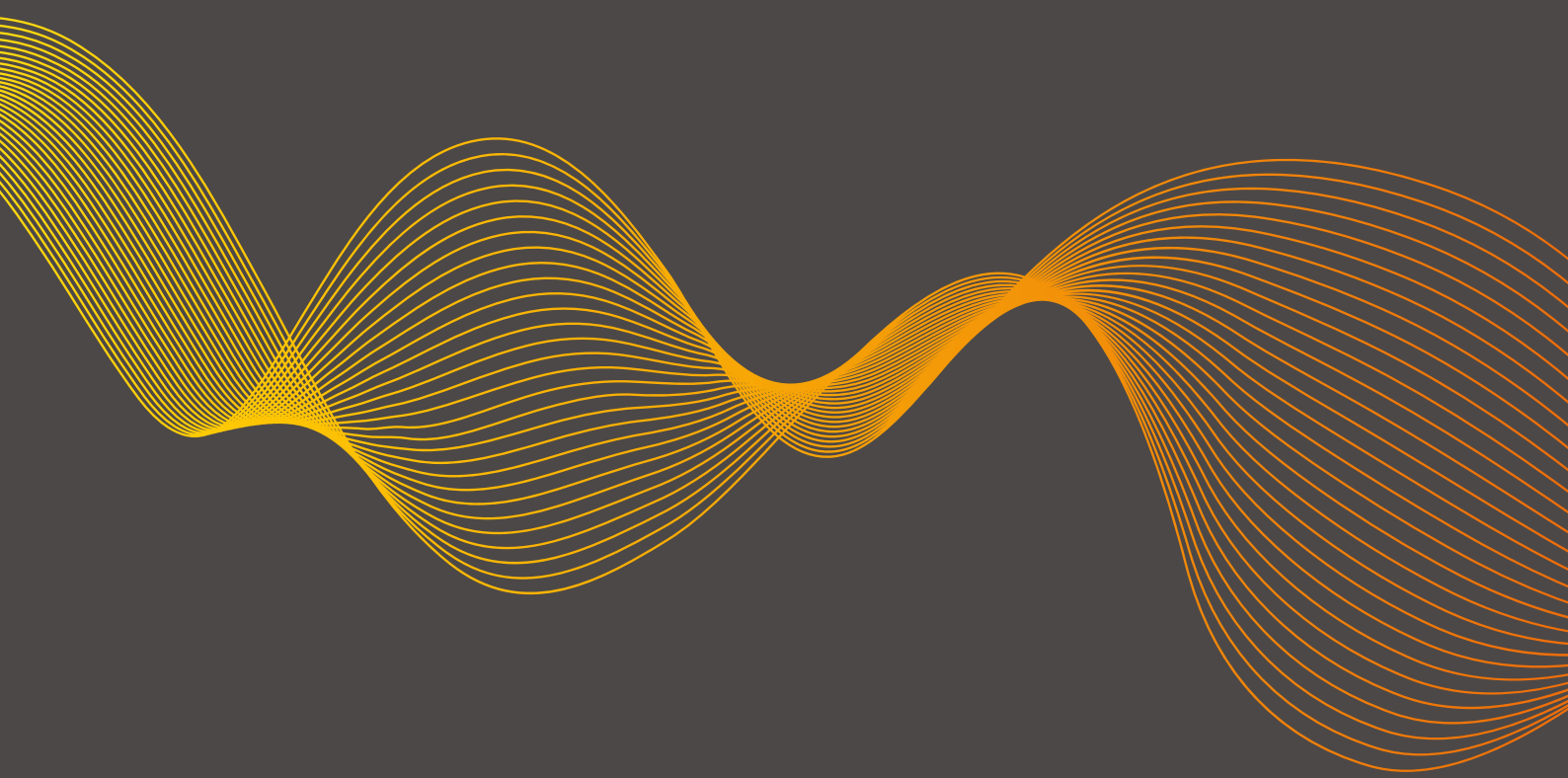
Material Changes

No material changes have been made to deliverables or budgets within the reporting period.

Accuracy Statement

The contents of this document are accurate and representative of our current project progress as of 25/06/21

Peter Chandler



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